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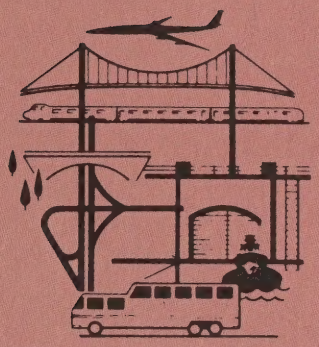
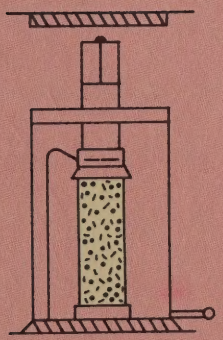
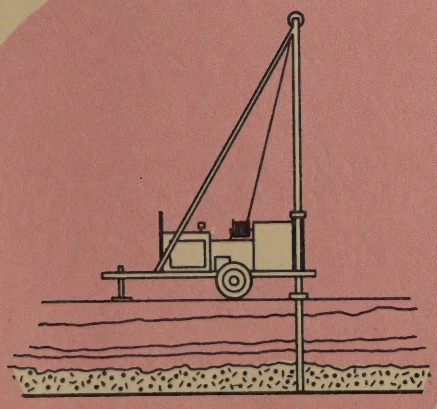
STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

SOIL MECHANICS
BUREAU







EARTH ANCHOR INSTALLATION AT CANTON-OGDENSBURG ON ROUTE 68

ST. LAWRENCE COUNTY

EDWARD MOODY
ASSOCIATE SOILS ENGINEER

NOVEMBER 1982

SM 238b (1/73)

TABLE OF CONTENTS

Introduction 1

Project Location 1

Contractual Arrangements 1

Site Conditions 1

Equipment 2

Installation of Earth Anchors 2

Conclusions 3

Appendix

Photographs 4-8

Inspector's Daily Reports 9-11

Plan, Elevation & Section from Contract 12-13

Specification from Contract 14-21

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INTRODUCTION

On July 26 & 27, 1982, Steve Lamb and I visited this project to observe the installation of earth anchors. The anchors will be used in a load-deflection field test of a jack arch bridge conducted under the supervision of Bob Kissane of the Engineering Research and Development Bureau. I understand that the structural capacity of this type of structure is very difficult to predict analytically. Several structures across the State will be loaded to develop load-deflection parameters which can then be used with limited deflection readings on other in-place structures to predict their capacity.

PROJECT LOCATION

The project is on State Route 68 in northern New York in St. Lawrence County northwest of Canton heading towards Ogdensburg. The construction contract incorporating this work encompasses four miles of work including minor profile and alignment changes, widening, and resurfacing. The 21 foot long jack arch structure to be tested will be replaced by a five foot diameter culvert.

CONTRACTUAL ARRANGEMENTS

The prime contractor is Gallo Construction Company, an open shop contractor. Atlantic Testing Company is the subcontractor responsible for coring of the bridge deck and conducting the subsequent load-deflection testing of the structure. Schnabel Construction Company is installing the earth anchors for Atlantic Testing.

The load testing program was added to the contract during the bidding period by amendment. The all-inclusive item, 16634.9999 Load Testing Program for Existing Structure, was bid at a lump sum price of $50,000. The specification calls for each anchor to consist of five 1/2 inch diameter wire strand tendons. Schnabel is installing rebars instead at a price of $21,000. The prime contractor is furnishing the air track drill, compressor and water pump to Schnabel.

SITE CONDITIONS

Drill Hole DAB-5 was progressed on short notice this past winter to establish the subsurface conditions at the earth anchor site. The boring was drilled through the embankment just outside of the guiderail on the east side of the north approach embankment. No samples were taken until a depth of 20 feet was reached. A very compact granular deposit; generally described as silty fine sand, gravelly; was encountered to 47 feet, the bottom of the boring.

The bottom of the creek under the bridge was an organic material over the granular deposit. The contractor constructed an earthen cofferdam on the east side of the structure, lowered the water level under the structure, and placed a granular working platform over the organic material.

who is Skip Skoglund?

EQUIPMENT

The drill rig was an air track run off a 700 cfs capacity Ingersoll compressor. Skip Skoglund would have preferred a slightly higher output compressor which would have increased their installation rate. The mast of the drill was aligned in a vertical position by the driller by eye. After the first section of casing was in the leads, a two foot level was used to check the verticality of the casing.

Disposable drill bits or driving points were installed on the casing by wrapping the bit shaft with a piece of packing tape and then forcing the bit into the drill casing.

The tendons furnished for this project were rods sixty feet long which were cut to the exact length on the job.

INSTALLATION OF EARTH ANCHORS

The layout and numbering (my designation) of the earth anchors are indicated on the attached sketch from the amendment. Skip Skoglund had estimated this project for Schnabel and had hoped to install the eight anchors over a three day period. This schedule proved to be optimistic.

Anchor No. 1 was installed on Friday, July 23, with a chopping bit. Anchors Nos. 2 and 3 were installed on Monday, July 26, also using chopping bits. The drill casing in Number 3 broke at 20 feet when they were trying to get the last few feet of the 40 feet of casing down. The casing was advanced with a combination of impact, washing and rotation when the chopping bits were used.

On Tuesday, Numbers 4, 5 and 6 were installed using a driving point instead of a chopping bit. It took approximately an hour to install No. 6 which was 40 feet long including the stick-up through the deck. About half of this time was consumed getting by or through an obstruction at a depth of about five feet. The next 10 foot section only took two minutes to install and the last 10 foot section took one half hour. Skip said they average 45 feet per hour in normal drilling conditions.

Once the casing was at the desired depth, the rebar tendon was cut to length and dropped into the casing. When it hit the bit at the bottom, it rebounded impressively. The drilling bit, which was only held to the casing by friction, was driven off by striking the tendon manually with a sledge hammer. The casing was held by a hydraulic casing extractor which is an hydraulically powered ram with a spring loaded wedge chuck. When a sledge hammer doesn't dislodge the bit, the drill head can be used for greater impact. On several of the drill casings on this project, the chopping bits would not dislodge with either method. Therefore, the casing was withdrawn, a driving point put on in place of the chopping bit and the casing redriven. The driving points were then successfully knocked loose.

Number 6, where the original casing broke at 20 feet, was redriven with a driving point adjacent to the old casing with no apparent problem.

Unfortunately, the time we had available to spend on this project due to other commitments and Schnabel's slow progress prevented us from seeing the grouting of the tendons or any load testing.

Copies of the inspector's reports documenting these phases of the work are attached. As noted, 7 of 8 anchors sustained a maximum load of 72 tons. Number 3 failed at 20 tons. A second anchor was placed at this location.

In discussions with Engineering Research and Development Bureau personnel after completion of the load-deflection testing programs, we learned that the anchor system had satisfactorily sustained the imposed loads.

CONCLUSIONS

Other than becoming familiar with the equipment and drilling procedures, very little was learned about earth anchors on this project. They were added to the contract late by amendment. The specifications did not clearly cover the load testing requirements for acceptance of the anchors, but due to the short term loading requirements this was not a problem.

It would appear beneficial to have our Earth Anchor Specifications as end result specifications to give the contractor the greatest amount of flexibility.

PHOTO 1

A chopping bit on the left and a drive point are shown with a camera lens cover. The lens cover is 2-1/2 inches in diameter.

PHOTO 2

A bearing plate and a threaded nut are shown. The conical faces on the nut and in the plate can allow a smooth transfer of load if minor misalignment occurs. The straight cylinders in the upper portion of the photo are threaded unions to connect two lengths of bar.

PHOTO 3

Three casings are shown. The third, away from the viewer, is being installed with a chopping bit. The upward flow of drilling fluid is visible through the construction blanket of granular material. The piled up material in the background is the earthen cofferdam.

PHOTO 4

The airtrack is progressing the casing.

PHOTO 5

The airtrack is used to lift the tendon into the casing.

PHOTO 6

Inserting the tendon into the casing.

PHOTO 7

The airtrack impact hammer is applied to the tendon to try to knock loose the chopping bit. An hydraulic casing extractor and a long wrench are being used to hold the drill casing.

PHOTO 8

A disassembled hydraulic casing extractor head is being cleaned.

MURK 1c (11/78)

INSPECTOR'S DAILY REPORT

JOB STAMP

D96917
P. I. No. 7006.08.321
Ogdensburg - Canton
F. A. Proj. No.: FR-167 (102)
St. Lawrence County
Contractor: Gallo Brothers, Inc.

Date: 7-28-82

Day of Week: S M T W T F S

I.R. No.: 161

Sheet No. ____ of ____ Sheets

If pertinent to the Construction Operation	AM	PM
Weather		
Temperature		

DESCRIPTION OF WORK PERFORMED AND INSPECTED

Specify for Each Operation: Item No., Sub-Contractor (if any), Location and Nature of Work

ITEM 116634.9999 LOAD TESTING PROGRAM FOR EXISTING STRUCTURE

① Subcontractor (Schnabel Corp.) finished driving casing for placement of soil anchors. Depths of the casings below the bridge deck are: #1 - 38.25' #3 - 38.58' #5 - 38.50' #7 - 38.58'
#2 - 38.25' #4 - 38.50' #6 - 38.67' #8 - 38.25'
(see back for locations of cores)

② Subcontractor (Schnabel Corp) installed tendons for soil anchors in each casing (each tendon placed was 38 LF in length)

③ Subcontractor (Schnabel Corp.) injected grout in casing #4 at a pressure of 1000 lbs. The grout was a mixture of 6-88 lb bags of Portland Type I cement to 30 gallons of water

PAYMENT AT A LATER DATE

Number of Men & Equipment	Item No.	Quantities Placed Today	"F" if Final	Fiscal Share
1 air drill 1 foreman				
3 laborers				

The above described work was incorporated into this project and was inspected by

Susan E. Hentschel
Inspector's Signature

Reviewed by Gary F. Howard 7/28/82
☑ Engineer-in-Charge
☐ Resident Engineer
Date

☑ Reverse side used for additional remarks and sketches.

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MURK 1c (11/78) **INSPECTOR'S DAILY REPORT**

Date: 8-2-82

JOB STAMP

D96917
P. I. No. 7006.08.321
Ogdensburg - Canton
F. A. Proj. No.: FR-167 (102)
St. Lawrence County
Contractor: Gallo Brothers, Inc.

Day of Week: S M T W T F S

I.R. No.: 173

Sheet No. ____ of ____ Sheets

If pertinent to the Construction Operation	AM	PM
Weather		
Temperature		

DESCRIPTION OF WORK PERFORMED AND INSPECTED

Specify for Each Operation: Item No., Sub-Contractor (if any), Location and Nature of Work

ITEM 16634.9999 - LOAD TESTING PROGRAM FOR EXISTING STRUCTURE
Subcontractor (Schnabel Corp.) tested soil anchors #1,2,3,4,5,6,7,8 (see I.R. #161 for layout of soil anchors), to a maximum load of 72 tons. Anchors #1,2,4,5,6,7,8 passed but anchor #3 failed at a pressure of 20 tons. Subcontractor subsequently placed and grouted a second anchor in hole #3 at a depth of 38.5'. Will test this anchor on Thurs, Aug. 5. PAYMENT AT A LATER DATE

ITEM 203.02 - UNCLASSIFIED EXCAVATION & DISPOSAL
Benching successfully completed from STA. 159+00± RT to STA. 162+00± RT & STA. 195+00± RT to STA. 196+00± RT, but inadvertly was overlooked for payment purposes. - FIELD MEAS. & INSP. BY SCH
PAY 0.6 X (300 L.F. + 100 L.F.) = 240 CY

Number of Men & Equipment		Item No.	Quantities Placed Today	"F" if Final	Fiscal Share
1 hydraulic jack	1 foreman	203.02	240 CY	F	P
1 air drill	1 laborer				

The above described work was incorporated into this project and was inspected by

Susan S. Hentschel
Inspector's Signature

Reviewed by Gary T. Howard 8/3/82
Date

☑ Engineer-in-Charge
☐ Resident Engineer

☐ Reverse side used for additional remarks and sketches.

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SOIL MECH

1 x x 8

2 x x 7

3 x x 6

4 x x 5

CANTON

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AUG - 5 1992
N.Y.S. DOT
SOIL MECHANICS

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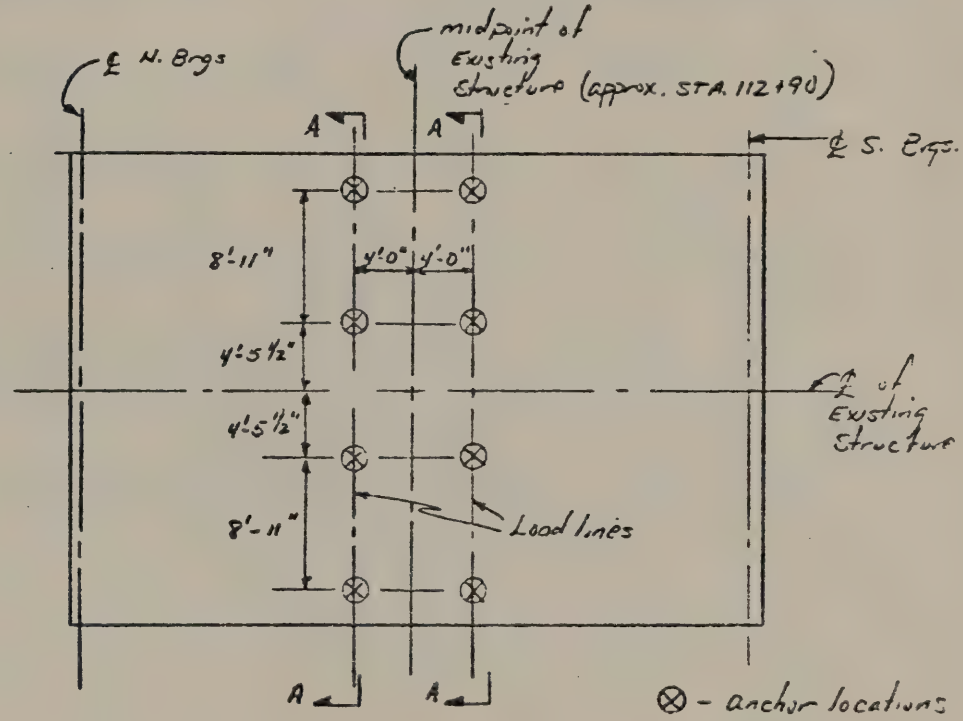
Sheet 1 of 4 Prep. by RJC Date 1/27/82

Checked by ___ Date ___ Design Ident. SH. No. ___

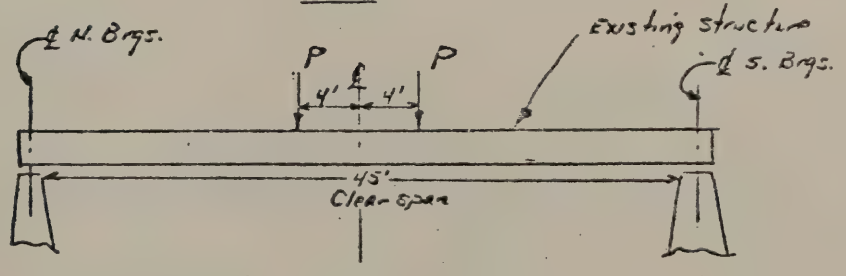
County ___ P.I.N. 7006.08

Job Title Rte 68 over Indian Ck.

CONSTRUCTION JOB STAMP



Plan



ELEVATION

P = total line load of 480 kips

Note: The procedures for Stage Construction and for Maintaining Traffic as outlined on Drawing MT-1 are mandatory at STA. 112+90 2/16

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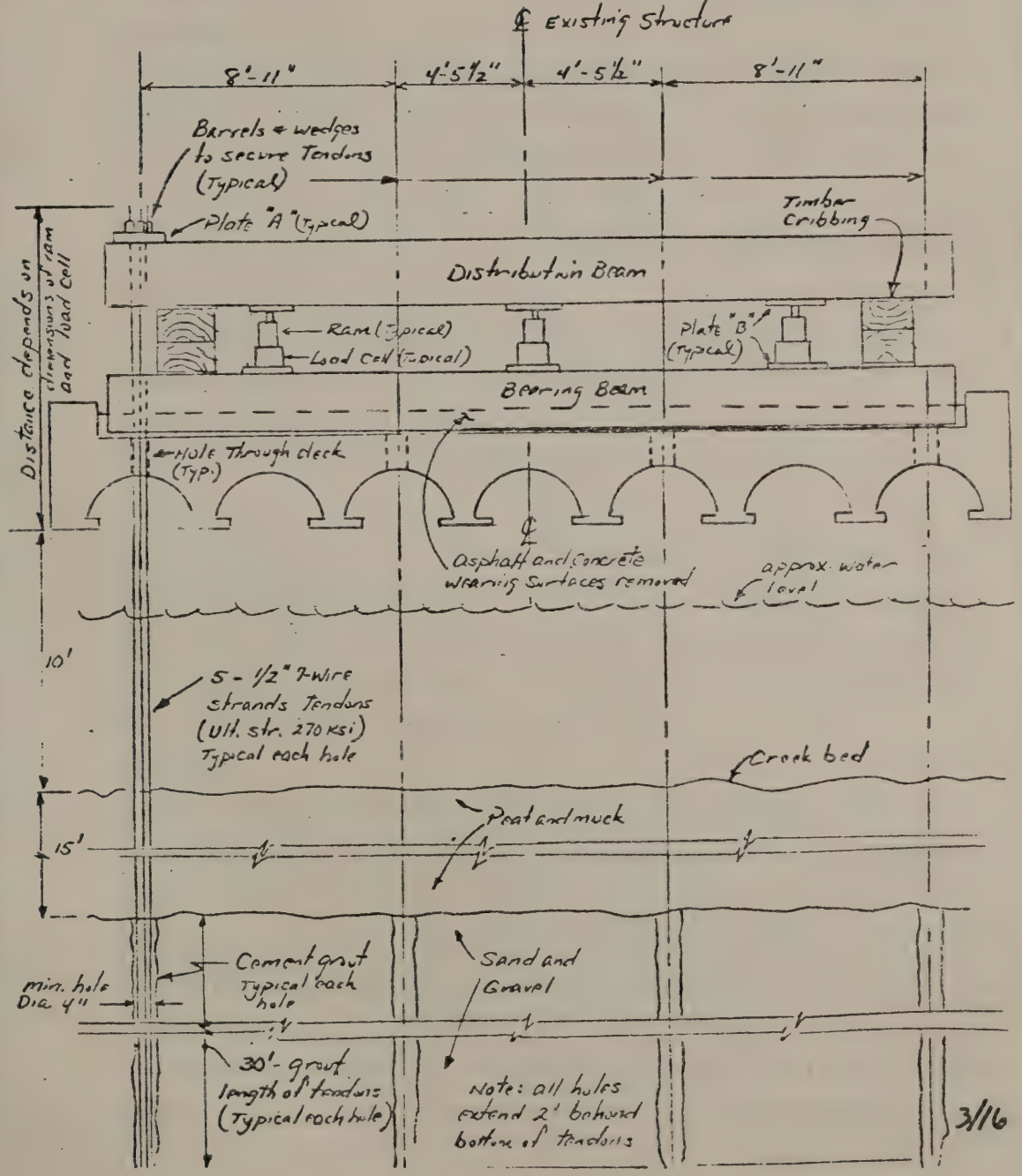
Sheet 2 of 4 Prepared by RJK Date 1/27/82

Checked by ___ Date ___ Design Ident. Sht. No. ___

County ___ P.I.N. 7006.08

Job Title Rte 68 over Indian Ck.

CONSTRUCTION JOB STAMP



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Item 16634.9999 - Load Testing Program for Existing Structure

Description

The structure to be removed will be instrumented and load tested prior to dismantling. The bridge will be instrumented with electrical resistance strain gages and deflection devices. These instruments will be monitored under the application of vehicle loadings and various loads applied by hydraulic rams. The State will provide all vehicle loads and equipment for monitoring the strain gages and deflection devices.

Under this item, the Contractor shall furnish an instrument trailer, access to the instrument trailer and structure, and all labor (exclusive of that to be performed by state forces) for the testing program as specified herein or as directed by the Engineer. The anchor and loading systems, as required by the contract documents, including its assembly and operation, certain measuring devices as described under Materials of this item, and the labor and equipment to sample the concrete and steel, will be furnished by the Contractor. The Contractor shall also provide temporary electrical service lines (100 amp 220 volt power) to the trailer, scaffolding, and watchman service. The electrical service shall incorporate ground fault arrestors.

Materials

The instrument trailer shall conform to Subsection 637-2.03A, Engineer's Office (Type A), except that the only furnishings required are a suitable office desk with drawers and locks, and two chairs. The trailer shall conform to the following provisions of Subection 637-2.02, General Requirements for All Engineer's Offices: A) Lighting, B) Heating and Cooling, K) Maintenance, and L) Fire Extinguisher.

Tendons for the anchor system shall be 7-wire strands with a nominal diameter of 0.5 in. and shall conform to ASTM A-416 (ultimate strength 270 ksi).

6/16

D96917

Construction Details

A. Work by State Forces

The State will install the strain gages, deflection devices, and wiring required to conduct these tests. The State will also furnish the recording equipment, the vehicles, and personnel to supervise and conduct the testing. At the completion of testing, the State will remove all test equipment (exclusive of loading system) and wiring from the structure.

B. Anchor System

The contractor shall furnish the materials, equipment and labor required to install the anchors at the locations and depths indicated on the contract documents. The Contractor's staff shall include at least one member certified by the Contractor as experienced in the installation of anchor systems. This person shall be a Professional Engineer licensed to practice in New York State, and be familiar with the methods of construction outlined in Recommendations for Prestressed Rock and Soil Anchors, published by the Post Tensioning Institute, January 1980.

D 5 COPIES

The holes for the anchors may be either driven or drilled. Core drilling, rotary drilling, auger drilling or percussion drilling may be used. This work shall be done from the top of the existing structure. The hole diameters shall not be less than 4 inches and the holes shall extend a minimum of two feet beyond the specified bonded tendon length. All anchor holes shall be installed vertical to within $\pm$ 3 degrees. If a hole will not stand open, casing shall be installed as required to maintain a clean and open hole.

Prior to placement, each tendon shall be degreased along the bonding length using Acetone, MEK or MIBK. No residue is to be left on the tendons.

9/16

D96917

Other substances may be used for cleaning with the approval of the Engineer. The tendons in the grout length shall be installed in such a way as to insure that each tendon has a minimum of one-half inch of grout cover. Centralizers shall be made of a material not detrimental to the grouting and bonding process. Centralizers shall be provided at a maximum of 10 ft center to center spacing throughout the grout length.

The grouting operation shall be performed after all tendons are inserted in the holes. The grout to be used for the anchorage shall consist of a pumpable mixture of Type I, II, or III portland cement, sand and water and admixtures. Chemical additives which control bleed or retard set may be used. Expansive additives will not be allowed. Additives, if used, shall be mixed in accordance with the manufacturer's recommendations. The grout shall be capable of reaching a cube strength (AASHTO T 106) of 3500 psi in 7 days. Prior to placement of the grout, the Contractor shall submit the grout mix design to the Engineer for approval along with supportive certification from an independent testing laboratory verifying 7 day compressive strength test results, consistency and identification of constituent materials.

The grouting equipment shall be capable of continuous mixing and shall produce a uniform and thoroughly mixed grout free of lumps. The grout pump shall be equipped with a grout pressure gage capable of measuring 150 psi.

The grout shall be placed using a grout tube, filling each hole continuously from the bottom to the top of the grout length shown on the contract plans. If casing was used, grout may be pumped down the casing while the casing is extracted. After grouting is completed, the Contractor may remove the casing from the overburden. If the casings are withdrawn, a suitable method of insuring that the tendons do not shift position within the over-

10/16

D96917

burden shall be used, with the approval of the Engineer. After grouting, the tendons shall remain undisturbed until the grout has reached a cube strength of 3500 psi.

C. Loading System

The Contractor shall furnish the material, equipment, and labor to construct and operate the loading system detailed on the contract documents. He may submit alternate plans and details for a loading system to apply the loads of the magnitude and at the locations shown on the contract documents. Except for the tendon securing barrels and wedges, which shall be compatible with the tendons, all steel used in the loading system shall conform to ASTM designation A-36. Any proposed changes shall be approved by the Engineer.

The hydraulic system (including rams, hoses, connections, pressure gages and pumps) shall be capable of safely applying the loads shown on the contract plans and monitoring loads with pressure gages to within $\pm$ 2 percent. Since the maximum applied loads are expected to produce large deformations, the hydraulic rams used shall provide a minimum extension (stroke) of 12 in. and be capable of remote operation and monitoring at a minimum of 25 feet from the structure. The Contractor shall submit details of the hydraulic system to be supplied, including pressure vs load information, to the Engineer for approval at least three weeks before testing is to begin.

The load cells shown on the contract documents (between the loading frame and the hydraulic rams) shall be strain gage type units having nominal input and output resistances of 350 ohms. The units shall accept DC excitation and have a safe overload rating of at least 150 percent of the maximum capacity of the hydraulic system. The Contractor shall submit details of the load cell units to be supplied, including calibration and termination information to the Engineer at least three weeks before testing is to begin.

11/16

D 96917

Output from the load cells will be monitored with recording equipment provided by the State.

D. Scaffolding

The Contractor shall furnish and erect temporary scaffolding, including necessary ladders to provide access to the underside of the bridge during instrumentation and testing operations. Scaffolding shall conform to current OSHA standards. Scaffolding shall provide access to the full width of the bridge and extend 6 feet on each side of midspan. Scaffolding shall be erected clear of the water surface and shall not be placed more than 4-1/2 feet below the bottom flange of the structure. Scaffolding shall be constructed of good sound material, firmly braced, and maintained free of wracking or shakiness. Although total collapse of the bridge is unlikely, loads of sufficient magnitude to cause some debris to fall and damage the scaffolding are possible. When no longer required, and when directed by the Engineer, the Contractor shall remove the scaffolding.

E. Removal of Concrete and Asphalt

The Contractor shall furnish the equipment and labor to remove concrete from the top and underside of the structure near midspan to expose the flanges of the steel beams, where directed by the Engineer. Approximately 20 to 40 cu. ft of concrete will be removed, depending on the state's requirements at the time. Also, the Contractor shall furnish the equipment and labor to remove asphalt and the concrete wearing courses from the top surface of the structure. Approximately 1000 cu. ft of material will be removed, depending on the State's requirements at the time.

F. Test Sequence and Schedule

The Contractor shall schedule his work so that installation of instruments and the performance of load tests can be conducted during the months

12/16

D 96917

of April through October. The Contractor shall notify the Engineer two weeks in advance of the date when the structure will be closed to normal traffic and the electrical service, scaffolding and instrument trailer will be available for use by the State.

The contractor shall install the anchor system. The Contractor will then erect the scaffolding and remove materials from the structure to expose selected areas of the steel beams for gaging by State forces. The State will require approximately 4 days of unhindered access to the top and underside of the bridge to install strain gages, deflection devices, and wiring.

Upon completion of these tasks, the State will perform a series of live-load vehicle tests. These tests will start and finish in one working day. After these tests, the Contractor shall remove the asphalt and concrete wearing courses from the entire top surface of the structure. The Contractor shall provide access to the structure for test vehicles after removing this material. The Contractor shall notify the Engineer two working days in advance of the date when the structure will be cleared of this material. The State will then repeat the live-load vehicle tests. One working day will be required for the State to perform the second series of tests.

Upon completion of live-load vehicle testing, the Contractor shall install the loading system. The contractor shall also remove concrete cores from the structural deck during this time period. The Contractor shall notify the Engineer two working days in advance of the date when the loading system will be operational.

Load testing using the loading system will start and finish in one working day. During the testing, the Contractor will operate the hydraulic system and apply various increments of load or deflection to the structure, as

14

D96917

directed by the Engineer. At specified load levels, the Contractor will be required to hold the load for approximately 15 minutes while State forces monitor instrumentation. The structure will be subjected to several cycles of loading and unloading to identify various stages of distress.

Although total collapse of the structure is unlikely, loads of sufficient magnitude to cause significant deformations will be applied. The Contractor shall take adequate safety precautions to prevent injury to personnel and damage to equipment during these tests. In the event of a collapse, the Contractor shall remove the debris and clean up to the satisfaction of the Engineer.

After testing has been completed, the State will require one working day to remove instruments and wires. The Contractor shall, as directed by the Engineer, assist in this removal operation. Then, the Contractor shall remove the loading system. All casings and anchor tendons shall be removed as directed by the Engineer.

G. Sampling of Structure

All concrete cores removed from the structure during installation of the anchors shall be retained for testing. Also, the Contractor will be required to obtain four 4-in. diameter cores from the structural deck of the bridge at various locations, as directed by the Engineer. After completion of loading testing, the Contractor shall obtain two coupon samples from the bottom flange of each steel beam at locations designated by the Engineer. Coupons shall be at least 4-in. wide and 30-in. in length. Concrete core and steel coupon samples shall be clearly identified as to location taken from on the bridge, and shall be sent to the NYS Department of Transportation, Engineering Research and Development Bureau at Building 7A of the State Campus site, 1220 Washington Avenue, Albany, NY 12232.

14/16

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H. Watchman Service

The contractor shall furnish a watchman, who will be stationed at the instrument trailer on the site, specifically to protect the instruments and recording equipment against damage or theft. Recording equipment and instruments will be on the site approximately one week prior to live-load vehicle testing. If a significant time period (greater than two weeks) occurs between vehicle testing and loading system testing, the recording equipment and instruments will be removed from the site during this period. Watchman service shall be furnished continuously at times when the Contractor's forces are not working and recording equipment and instruments are on the site.

I. Method of Measurement

Payment will be made at the lump sum bid for this item.

J. Basis of Payment

The lump sum price bid shall include the cost of all labor, material, and equipment necessary to complete the work. The cost of the instrument trailer, watchman service, electrical service, and parking areas shall be included in this item.

Progress payments will be made in accordance with the following schedule:

1. Forty percent of the lump sum price bid will be paid after the anchors have been installed, the strain gages and accessories have been delivered to the State, and the instrument trailer, electrical service, and scaffolding have been set up.
2. Forty percent of the lump sum price bid will be paid after loading system testing is completed.
3. The remainder of the lump sum price bid will be paid after the loading system has been removed, concrete and steel samples have been delivered to the state, the instrument trailer disposed of, and electrical service and watchman service are terminated.

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